

## **ACTIVITY REPORT – MOUNTAIN PASS MINE**

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### ***Year 1: reconnaissance, mapping, and structural data collection***

#### **Introduction**

Our research group has successfully completed our first full year of our research on paleo-fluid flow controls and chemistry. Our only difficulty has been the result of confusion on the part of Moly Corp/Unocal/Chevron, following the retirement of their mine site geologist. There seems to be some problems with the company locating the geology and structure maps for the mine site. I have worked with their staff, but no one is sure where the maps have been stored, and it has been difficult obtaining proper release of the information with all of the recent changes in ownership. We are hopeful that the company will be able to provide the requested information soon.

Our fieldwork has consisted of several visits to the site by the principle investigator, and a major project in which seven senior geology students participated as part of an advanced geological mapping course. One of these students has been retained, through a stipend, to complete additional work in the field.

We have produced maps and detailed structural data for three areas of interest around the mine site. These include Eastern Mohawk Ridge, The main Open Pit, and a portion of Wheaton Wash (Figure 1).

#### **Eastern Mohawk Ridge**

In the Eastern Mohawk Ridge area, a significant structural boundary was mapped (Figure 2). This thrust fault contains ample evidence of pale-fluid flow (e.g., sulfide mineralization as chalcopyrite, galena, sphalerite). However this period of fluid flow involved high temperature, reducing fluids, and most likely occurred during the main period of (Tertiary?) sulfide mineralization associated with emplacement of other local sulfide deposits such as the Sulfide Queen and Mohawk ore bodies.

Evidence of later, lower temperature fluid flow, is located exclusively within a zone of kaolinized fault breccia and gouge 1-4 feet thick and centered upon the thrust fault. Well-formed secondary calcite and gypsum crystals are observed to have grown in some portions of the fault gouge. This fault appears to presently serve as a conduit for minimal and highly localized meteoric fluid flow within portions of the fault itself, mainly as interconnected pockets and fractures which could best be modeled as fracture flow. The very elevated clay content of the gouge and breccia probably serve as a barrier to significant cross-fault fluid flow. In addition, the limited flow across the fault or leaking from the fault, itself has

placed calcite-saturated fluids from the carbonate unit to the west into the fracture flow. Thus, while the fault may be a conduit for limited flow within the fault itself, it most likely serves as an effective barrier to fluid flow to the west.

### **Eastern Wheaton Wash**

The “North Fault,” a significant structure, lies within the area of Wheaton Wash that was mapped (Figures 1 and 3). Bedrock consists of undifferentiated gneiss and coarse-grained sillimanite gneiss. Juxtaposed gneiss units, abrupt changes in foliation, and a breccia unit which crops out in several places delineate the trace of the North Fault. The nature of the breccia unit must be further examined, as in places this unit appears to contain fragments of pyroclastic material. Apparent offset of an andesite dike suggests a minimum right-lateral strike-slip displacement of 650 feet along the North Fault. The south-eastern terminus of the fault is poorly defined and additional work may be required if this sector is determined to be of importance.

Fluid flow along the North Fault structure is not sufficient to produce springs, seeps, or vegetation anomalies.

One spring with a maximum observed flow rate of 5 liters/minute (March 2006) was observed to emerge at the base of a highly competent andesite dike. This spring is seasonal and flow completely stopped by August 2006. The field relations and observations suggest a shallow, fracture flow dominated spring system. Stable isotope and geochemical samples were obtained and are preserved by acidification and refrigeration for future analysis.

### **Main Pit Structural Data**

Detailed observations were made of the Celebration Fault Zone within the main open pit of the Mountain Pass Mine (Figures 4, 5, and 6). The location of this fault and the general character of the exposure is shown in Figure 4.

The upper portions of the fault are almost completely cemented by a white “calcite.” This calcite is banded at the 1-cm to 10-micron level and contains inclusions and bands of other minerals, and will be examined in detail in next years work. Not only are fractures filled with this “calcite,” brecciated zones are completely cemented by this material (Figure 4). The “calcite” does not exist in any significant quantity below the 4500 level of the mine, with the most pervasive mineralization occurring between the 4700 and 4600 levels. This “cap” of secondary mineralization serves as a low permeability barrier to downward fluid flow and local meteoric recharge, except where disrupted by mining activities. Recharge of the more permeable lower portions of the Celebration Fault through this well-cemented upper zone should be very limited, and only then, through very discrete zones where porosity is fortuitously linked. The lower portions of the fault below 4500 level are highly fractured, and mine personnel report that this structure “makes significant water” in the deepest levels of the mine.



Detailed structural observations were made at stations on both either side and within the Celebration Fault itself. Our method involved using a “hula-hoop” of known area ( $0.58 \text{ m}^2$ ) to define a station. The station would be swept and washed clean, and then the orientation of every fracture within the hoop would be measured and plotted on a rose diagram (Figure 5). The length of each fracture within the hoop would also be measured and the total length of fractures per  $\text{m}^2$  computed and plotted (Figure 6). Within the Celebration Fault itself, calcite veining was interpreted to represent secondary infilling of primary fractures, and was recorded as such. Few “unhealed” fractures were observed within the upper portion of the Celebration Fault Zone.

The orientation of fractures to the west of the Celebration Fault (Figure 5, view is approximately to the north) is roughly N-S. Within the fault zone the fractures are oriented roughly NW-SE. East of the fault the fractures have a bimodal orientation preference, probably due to the position of this block between the Celebration Fault and the Goldstrike Fault (Figure 4). Station 3, located 10 feet from the fault, was the only station west of the fault to show fracture orientations that are similar to the fault itself.

Fracture densities are quite low ( $5.5$  to  $10.9 \text{ m/m}^2$ ) adjoining the fault, but quite elevated ( $18.3$  to  $41.1 \text{ m/m}^2$ ) within the fault itself. The apparent increase in fracture density with depth results from the healing of multiple individual fractures into single recognizable zones by the “calcite” within the upper portions of the fault. The drop in fracture density between station 3 and station F1 (15 feet apart) is quite marked and abrupt.

The field observations suggest that while the lower portion of the Celebration Fault Zone is quite permeable, it has limited hydrologic reach beyond the fault zone itself. The upper portion of the fault has significantly reduced permeability due to secondary “calcite” mineralization. It is quite probable that this structure has the ability to transmit very localized recharge water significant distances at depth, with minimal hydrological or geochemical interaction with the atmosphere.

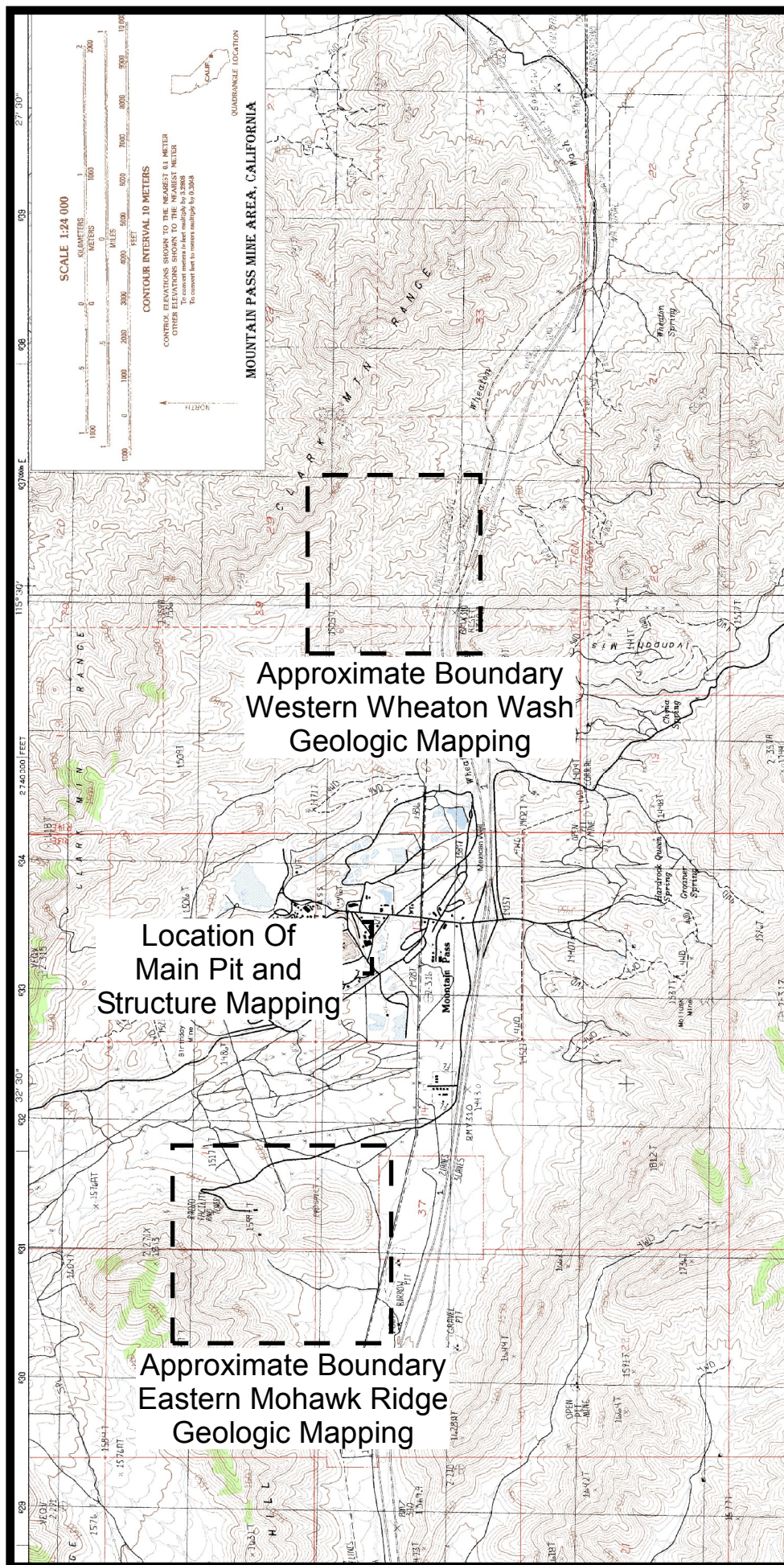
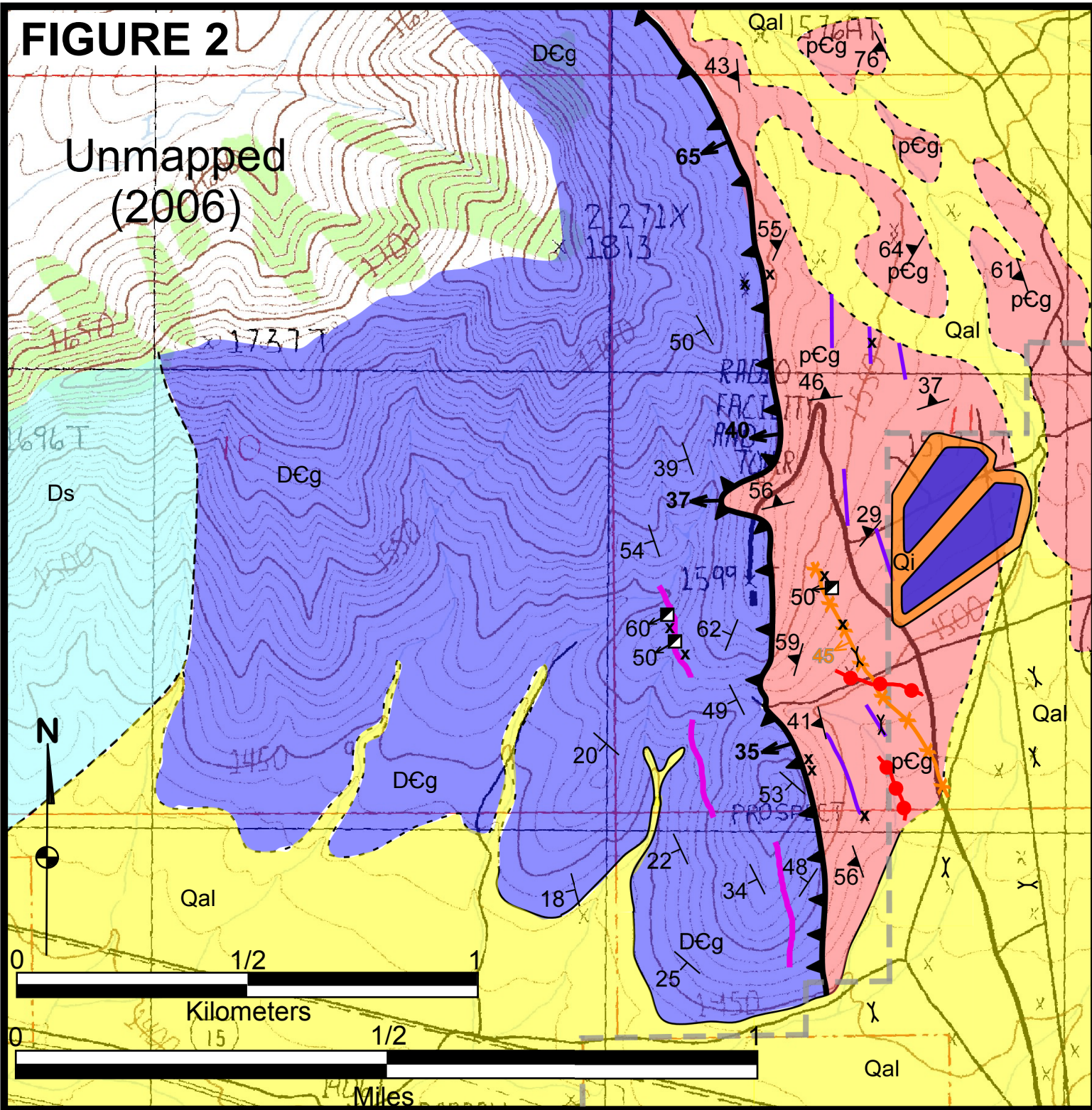


Figure 1



# FIGURE 2

Unmapped  
(2006)



## Key

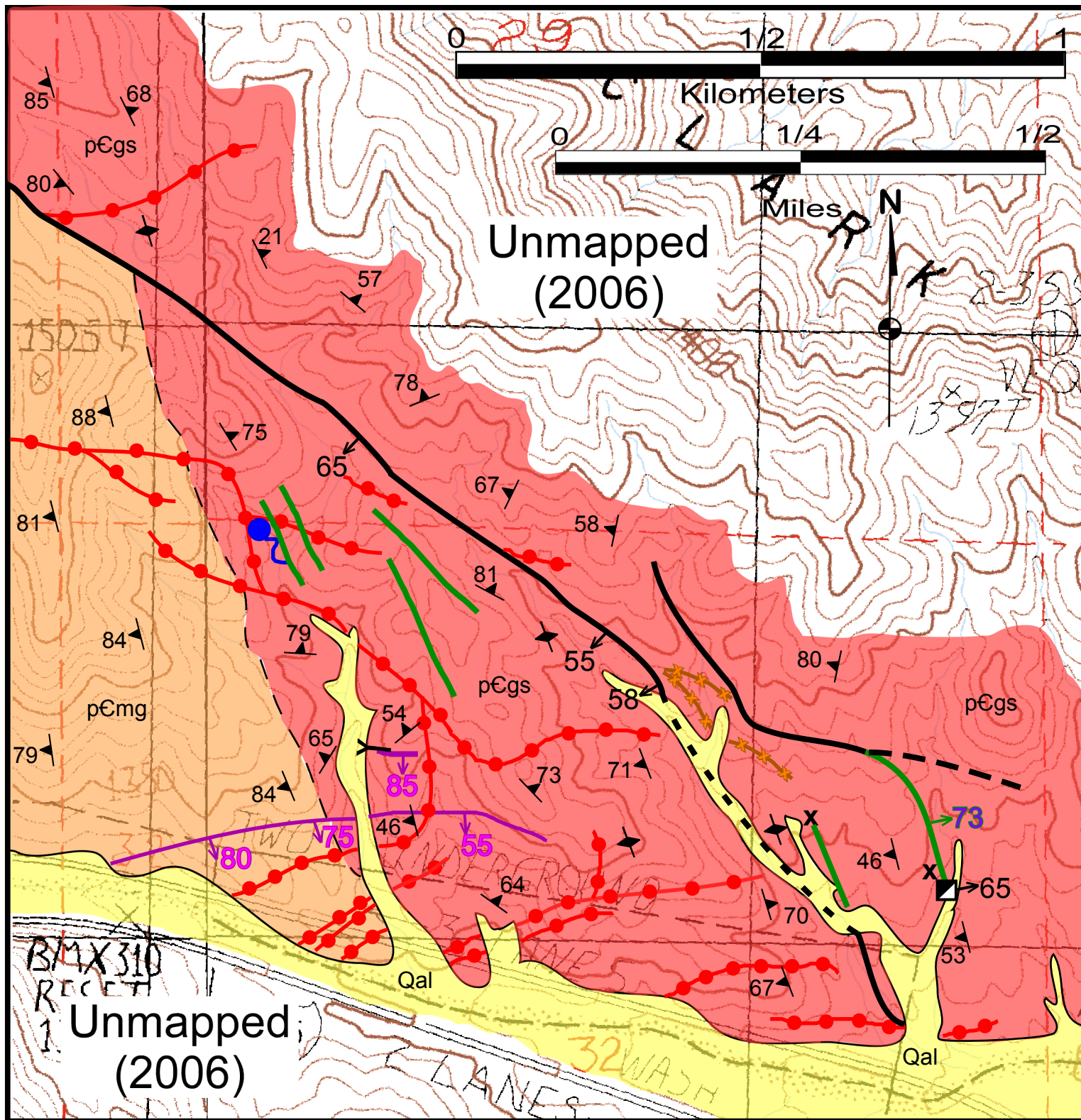
- Qi Recent earthen impoundment (water in blue)
- Qal Quaternary unconsolidated deposits (>2m thick)
- Ds Middle Devonian Sultan limestone
- DEg Cambrian-Devonian Goodsprings dolomite
- pCg Pre-Cambrian Undifferentiated gneiss

- 39 Strike and dip of bedding
- 39 Strike and dip of foliation
- Contact (dashed where aprox.)

- Andesite Dike
- Rhyolite Dike (dip)
- Shonkinite Dike
- Mineralized structure (cal+dol+gal±Cu)

- Prospect trench
- Prospect pit (< 2 m deep)
- Inclined shaft, showing direction and angle of dip
- Thrust fault showing angle of dip (barbs on overthrust side)
- Mtn. Pass Mine Boundary





### Key

**Qal** Quaternary unconsolidated deposits (>2m thick)

**pCmg** Pre-Cambrian Undifferentiated gneiss

**pCgs** Pre-Cambrian coarse grained sillimanite gneiss

39 Strike and dip of foliation

Contact (dashed where aprox.)

Spring, with tail indicating flow direction

x Prospect pit (< 2 m deep)

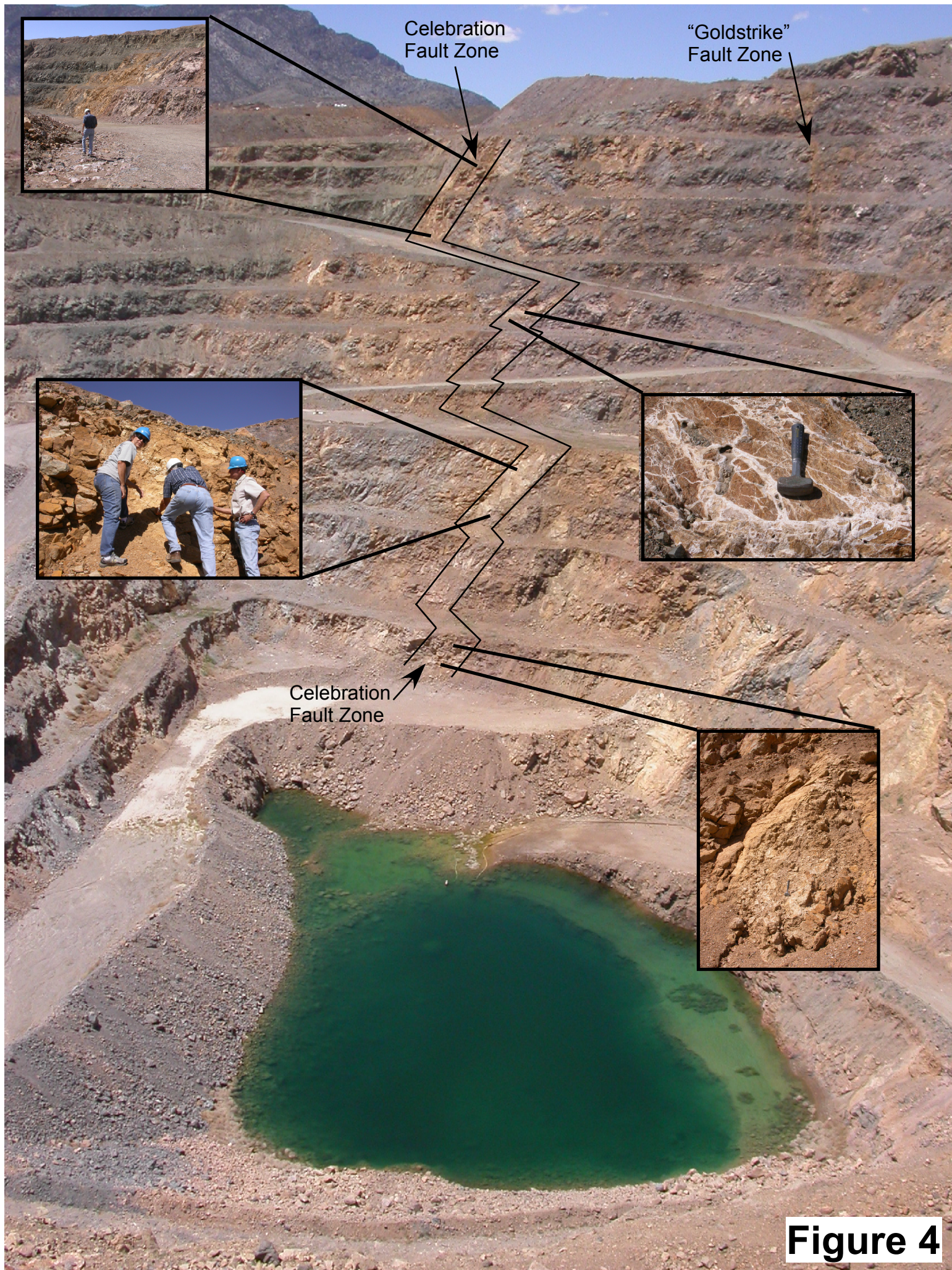
Adit, showing orientation

50 Inclined shaft, showing direction and angle of dip

Fault showing angle of dip

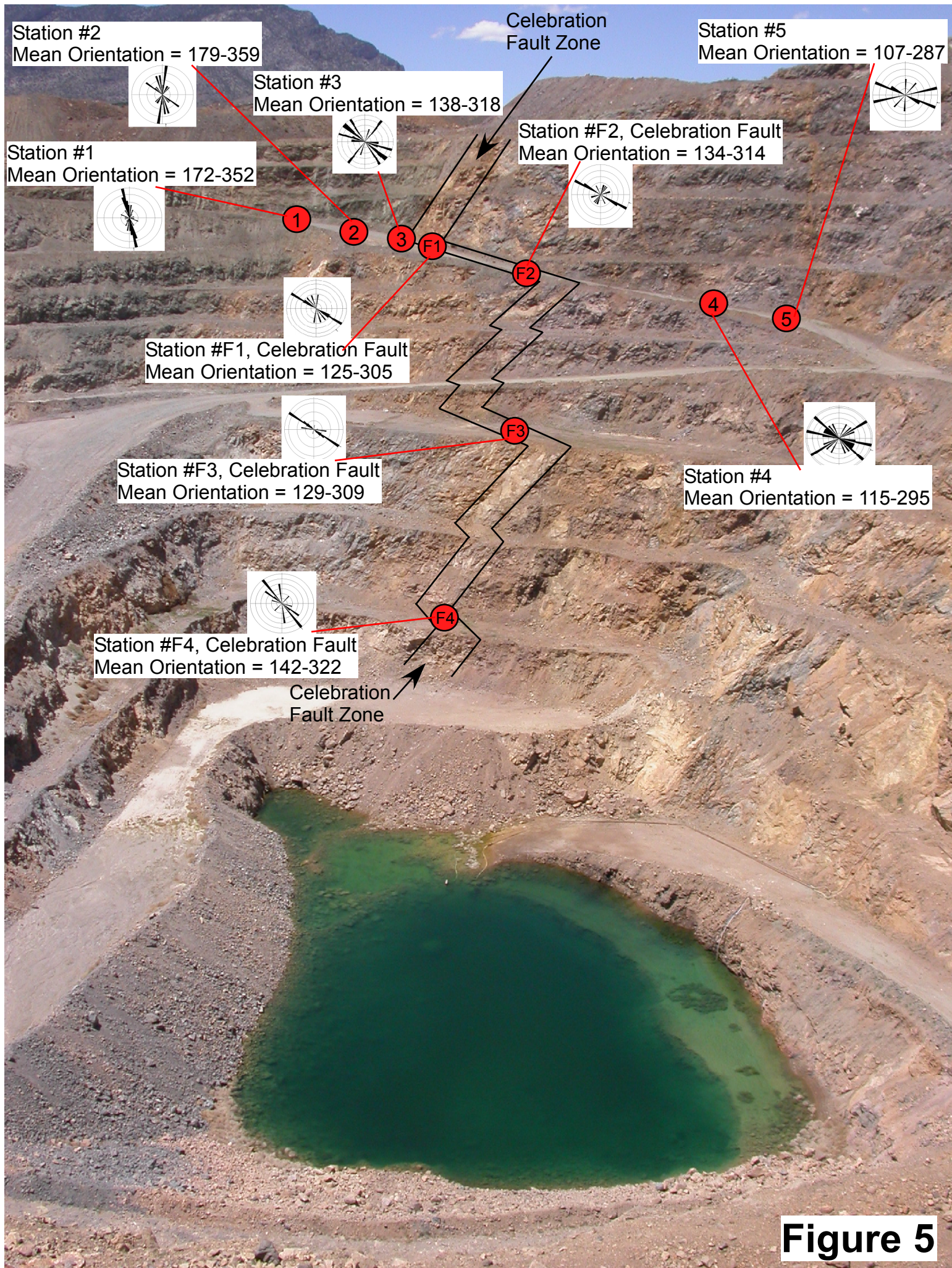
## FIGURE 3





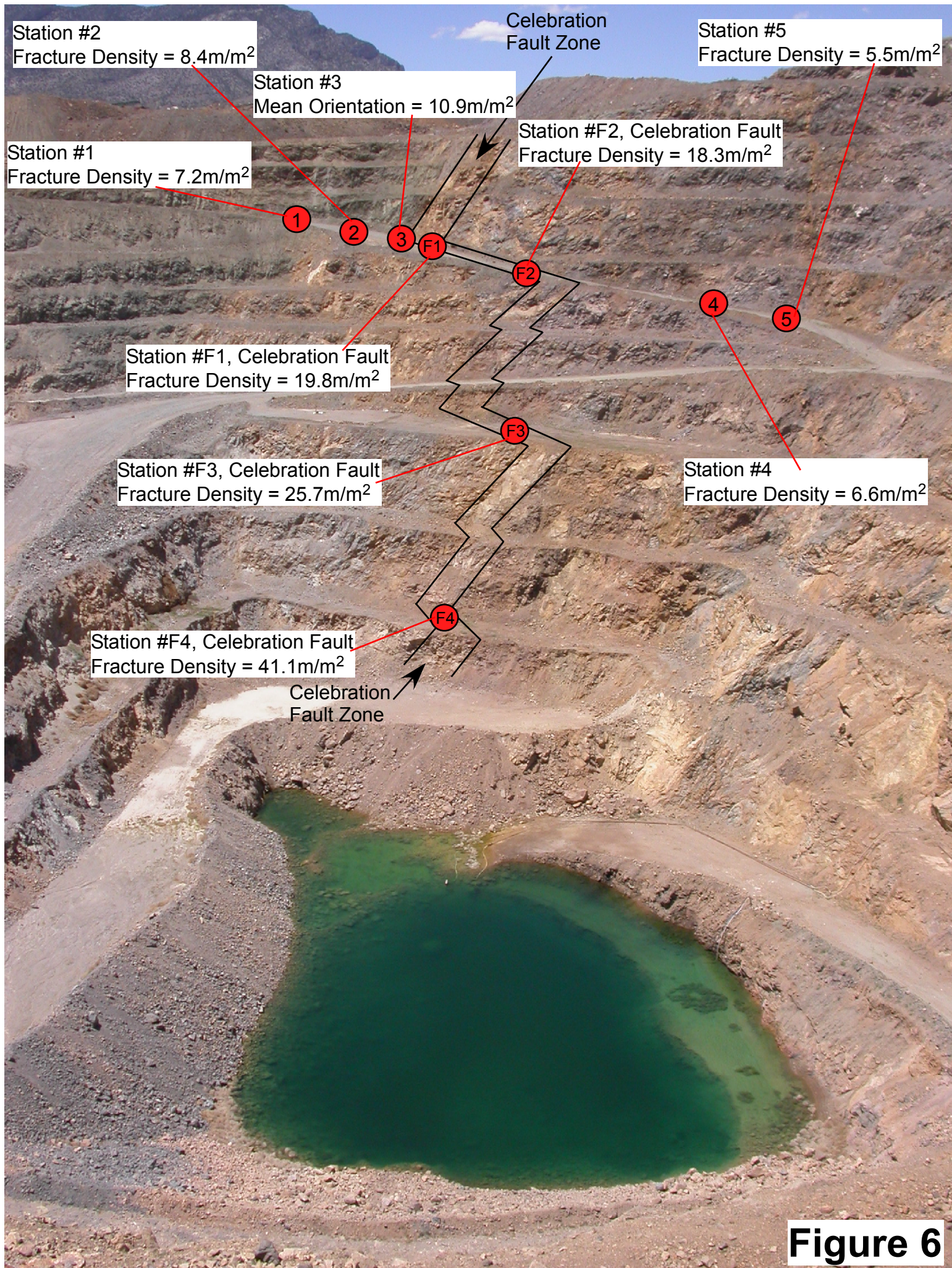
**Figure 4**





**Figure 5**





**Figure 6**